“Some Studies on Al and Mn Doped ZnS Nanoparticles”

A Synopsis Submitted to the Swami Ramanand Teerth Marathwada University for the Registration of

Doctor of Philosophy
In
Physics

Submitted By

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Introduction

Nanoparticles can lead to number of changes in optical, magnetic & Electrical Properties due to increase in the ratio of surface area to volume. The increase in the surface area to volume ratio, which is a gradual progression as the particle gets smaller, leads to an increase dominance of the behavior of atoms on the surface of particle over that of those in the interior of the particle. This affects both the properties of the particle in isolation and its interaction with other materials. High surface area is a critical factor in the performance of catalysis, Fuel cells, Batteries and Gas sensors. The large surface area of nanoparticles also results in a lot of interaction between the intermixed materials in nanocomposites leading to special properties such as increased strength, better sinterability [1].

The synthetic of nanoparticles dates back to the 19th century with Faraday reporting the preparation of colloids of relatively monodispersed gold nanoparticles [2]. Nanomaterials sometimes called nanopowders have grain size of the order of 1-100nm. Nanocrystalline materials have attracted extensive attention due to their unique properties and immense potential applications in nanodevice fabrications [3]. In almost all applications of nanomaterial devices, fabrication represents one of the most important challenges to their realization and commercialization. However, to afford the production, needs of cheap, clean, reliable and durable material with controlled properties for realistic and practical applications of nanotechnology, therefore production and characterization of nanoparticles is being hot field of research.

Literature Review

Zinc Sulphide (ZnS) is an important wide band gap (3.7 eV) semiconductor possessing a broad spectrum of application such as light emitting diodes, non linear optical devices, solar cells, solid state solar window layers. Flat panel devices, phosphors, photoconductors, catalyst, blue devices etc. [4].

Donne et al [5] investigated Mn doped ZnS nanoparticles and emphasized there use in photovoltaic devices. Improvement in magnetic and luminescence properties has been shown by Eryong et al [6] by using Fe as a dopant in ZnS.

H.C. Warad et al [7] report that the synthesis of luminescent nanoparticles of Mn doped ZnS with an emission peak at around 590 nm prepared by co-precipitation reaction from homogenous solution of Zinc and Mn salts. The nanoparticle consists of particles of 60 to 80 nm

in diameter each containing primary crystallites that was estimated from the x-ray diffraction patterns to be at around 2.2 nm.

T.T.Q. Hoa et al [8] proposed that the PL spectra of Mn doped ZnS nanoclusters exhibited both the blue defects related emission and orange Mn^{2+} ion related emission. Further more the blue emission was dominant at low temperatures mean while the orange emission was dominant at room temperatures.

ZnS and Al doped ZnS nanoparticles were successfully synthesized using simple chemical route by Y. Infahsaeng et al [9]. Further, structural analysis confirms that all prepared samples have cubic crystal structure.

Borse et al [10] was reported that the narrowly dispersed Pb-doped zinc sulfide nanoparticles were synthesized at room temperature using a chemical method in which the nanoparticle surfaces were passivated using mercaptoethanol. The maximum intensity of the broad green luminescence (~530 nm) from these nanoparticles was observed at an optimum dopant concentration of 0.104 Pb wt%.

Nada K. Abbas, etal [11] proposed a new method of preparation ZnS nano size at low PH. Nano particles of ZnS have been prepared by simple reaction between zinc chloride and sodium sulfide in aqueous solution at PH = 3 as source materials.

J.F. Xu etal [12] proposed a new method of preparation of ZnS nano particles by the inert gas evaporation technique with induction heating method. As prepared Zn particles were mixed with Na_2S solution. ZnS nanoparticles were synthesized under ultrasonic radiation.

Motivation for the Present Work

• Fabrication of good sensor is being one of the hot fields of research and with introduction of nanoparticles one can except enhancement in sensitivity due to high surface to volume ratio.

• In recent years, great interest in spintronic devices has stimulated extensive investigations on dilute magnetic semiconductors (DMS).

• Transition metal doped ZnS nanoparticles are promising candidates for applications in short-wavelength light emitting devices, field emission devices, solar cells, electronic and optoelectronic devices.

Objective of the Present Work

The objective of the present work is to study the, "Investigation of structural, Morphological, Optical and Electrical properties of Al and Mn doped ZnS nanoparticles."

Methodology

Preparation

• Al and Mn doped ZnS nanoparticles will be prepared by simple chemical method.

• Importance will be given to non transition elements as dopants to ZnS nanoparticles.

1. **Structural Characterization**

- **X-Ray Diffraction**

The powder X-ray diffraction pattern will be recorded for the Al and Mn doped ZnS nanoparticles. Lattice constant, crystal structure and particle size for the prepared samples will be studied.

2. **Morphological characterization**

• **Scanning Electron Microscopy (SEM)**

Surface morphology of the prepared samples will be studied by SEM.

• **Energy Dispersive X-ray Analysis (EDAX)**

The compositional analysis of the prepared samples will be studied by EDAX.

- **Transmission Electron Microscopy (TEM)**

The particle size of the prepared samples will be studied by TEM.

3. **Optical properties**

• **UV-Visible Spectrophotometer**

Formation of the doped ZnS nanoparticles will be characterized from UV-Visible spectrophotometer by calculating the energy band gap of the prepared samples.

• **FTIR Spectroscopy (Forrier transformation infrared spectroscopy)**

FTIR spectrum of the prepared samples will be recorded as it is an important and useful technique for determining functional groups, unknown materials, quality and the amount of components present in the prepared sample and it will also provide structural information of the samples.

4. Photoluminescence studies

The intrinsic and extrinsic defects n semiconductors may be explored by the nondestructive photoluminescence (PL) measurements. This provides information regarding the impurity and defect energy states even when they are present in very low concentrations and therefore is useful to understand defect structures in semiconductors.

5. Electrical Properties

• D.C. Electrical conductivity of the prepared samples will be carried out using source meter in the temperature range 300K to 600K by two probe method.

• The dielectric constant and dielectric loss of the prepared samples will be measured using LCR impedance analyzer in the frequency range of 10Hz – 3MHz.

Year wise Plan of work and targets to be achieve

First year

• Course work

• Literature review.

• Preparation of Al and Mn doped ZnS nanoparticles from simple chemical method

• Structural Characterization.

• Paper publication on the work.

Second year

• Surface morphology of the prepared nanoparticles will be studied.

• Optical properties of the prepared samples will be studied.

• FTIR spectroscopy studies.

Third year

• Electrical properties of the prepared samples will be studied.

• Photo luminescence studies.

• Data analysis and the results obtained will be communicated to the respective journals for publication.

• Submission of the thesis for the Doctoral degree.

References

1. Paul Holister, Jan-Willem Weener, Cristina Roman Vas, Tim Harper, Nanoparticles, Cientifica Publishers, Oct (2003).
2. Tito Trindade, Paul O'Brien and Nigel L. Pickett, Chem. Mater (2001)13, 3843-3858.
3. R.Elilarassi and G.Chandrasekaran, Optoelectronic letters, Vol.6 No.1, 1 January (2010).
4. J. Jie, W. Zhang, I. Bello, C.S. Lee, S.T. Lee, Nanotoday, 5(2010) 313.
5. A. Le Donne, S. Kanti Jana, S. Banerjee, S. Basu, S. Binetti, J. Appl. Phys, 113(2013) 014903.
6. N. Eryong, L. Donglai, Z. Yunsen, B. Xue, Y. Liang, Young, J. Zhifeng, S. Xiaosong, Appl. Surf. Sci., 257(2011) 8762.
7. H.C. Warad, S.C. Ghosh, B. Hemtanon, C. Thanachayanont, J. Dutta, Science and Technology of advanced materlas, 6(2005) 296-301.
8. T.T.Q. Hoa, N.D. Tha, S. McVitie, N. H. Nam, L.V. Vu, T.D. Canh, N.N. Long, optical materials, 33(2011) 308-314.
9. Y. Infasaeng, S. Ummartyotin, Results in Physics, 7(2017) 1245-1251.
10. Pramod H. Borse, W. Vogel, S.K. Kulkarni, Journal of Colloid and Interface Science 293(2006) 437–442
11. Nada K. Abbas, Khalid T, Al-Rasoul, Zainb J. Shanan, New Method of Preparation ZnS Nano size at low pH, Int. J. Electrochem. Sci.,8(2013) 3049-3056.
12. J.F. Xu, W.Ji, J.Y. Lin, S.H. Tang, Y.W. Du, Preparation of ZnS nanoparticles by ultrasonic radiation method, Applied Physics A 66, 639-641(1998)

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